Example of Single Server Queue Simulation

- A small grocery store has one check out counter. Customers *arrive* at the check counter at random times that range from 1 to 8 minutes apart. Assume that *inter-arrival times* are integer valued, with each of the 8 values having equal probability. The *service times* vary from 1 to 6 minutes – also integer valued – with probabilities shown in the table below
- Analyze the system by simulating the arrival and departure of 100 customers. Compute the measures of performance of the queuing model

Service Times (min)	Probability	Cumulative Probability
1	0.10	0.10
2	0.20	0.30
3	0.30	0.60
4	0.25	0.85
5	0.10	0.95
6	0.05	1.00

Model Responses and Simulation Table for the Grocery Store Simulation

Totals	437		327		132		459	112
Averages	4.37		3.27		1.32		4.59	1.13
Total number of customers = 100								
Step	Activity	Clock	Activity	Clock	Output	Clock	Output	Output
Customer	Interarrival time (min)	Arrival time	Service time (min)	Time service begins	Waiting time in queue (min)	Time service ends	Time customer spends in system	Idle time of server
1	0	0	3	0	0	3	3	0
2	8	8	3	8	0	11	3	5
3	8	16	5	16	0	21	5	5
4	4	20	3	21	1	24	4	0
5	2	22	4	24	2	28	6	0
6	1	23	2	28	5	30	7	0
7	3	26	3	30	4	33	7	0
8	7	33	2	33	0	35	2	0
9	2	35	5	35	0	40	5	0
10	1	36	4	40	4	44	8	0
11	5	41	5	44	3	49	8	0

Typical Performance Measures of a Queuing System

$$Average\ Waiting\ Time = \frac{Total\ time\ customers\ wait\ in\ queue}{Total\ number\ of\ customers} = \frac{132}{100} = 1.32\ min$$

$$Probability\ (wait) = \frac{Total\ number\ of\ customers\ who\ wait}{Total\ number\ of\ customers} = \frac{43}{100} = 0.43$$

$$Probability\ idle\ server = \frac{Total\ idle\ time\ of\ server}{Total\ run\ time\ of\ simulation} = \frac{112}{439} = 0.255$$

$$Average\ service\ time = \frac{Total\ service\ time\ (min.)}{Total\ number\ of\ customers} = \frac{327}{100} = 3.27\ min$$

Typical Performance Measures of a Queuing System

$$Average\ time\ between\ arrivals = \frac{Sum\ of\ interarrival\ times\ (min.)}{Total\ number\ of\ customers - 1}$$
$$= \frac{437}{99} = 4.41\ min$$

$$Average\ waiting\ time\ of\ those\ who\ wait = \frac{Total\ time\ customers\ wait\ in\ queue\ (min.)}{Total\ number\ of\ customers\ who\ wait}$$
$$= \frac{132}{43} = 3.07\ min$$

$$Average\ time\ a\ customer\ spends\ in\ the\ system = \frac{Total\ time\ customers\ spend\ in\ the\ system\ (min.)}{Total\ number\ of\ customers}$$
$$= \frac{439}{100} = 4.39\ min$$

Typical Performance Measures of a Queuing System

Average time a customer spends in the system =

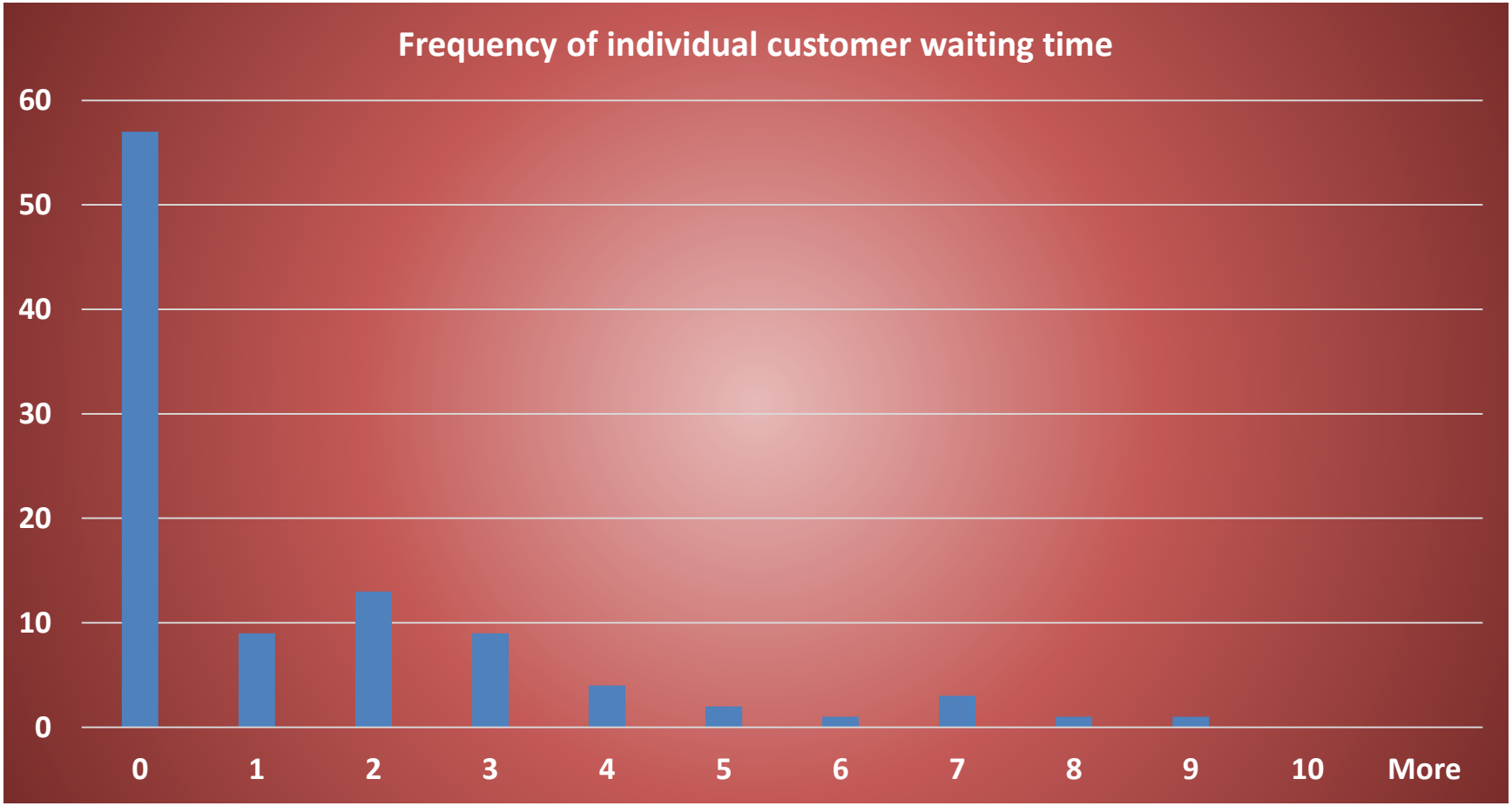
average time a customer waits in queue +

average time a customer spends in service

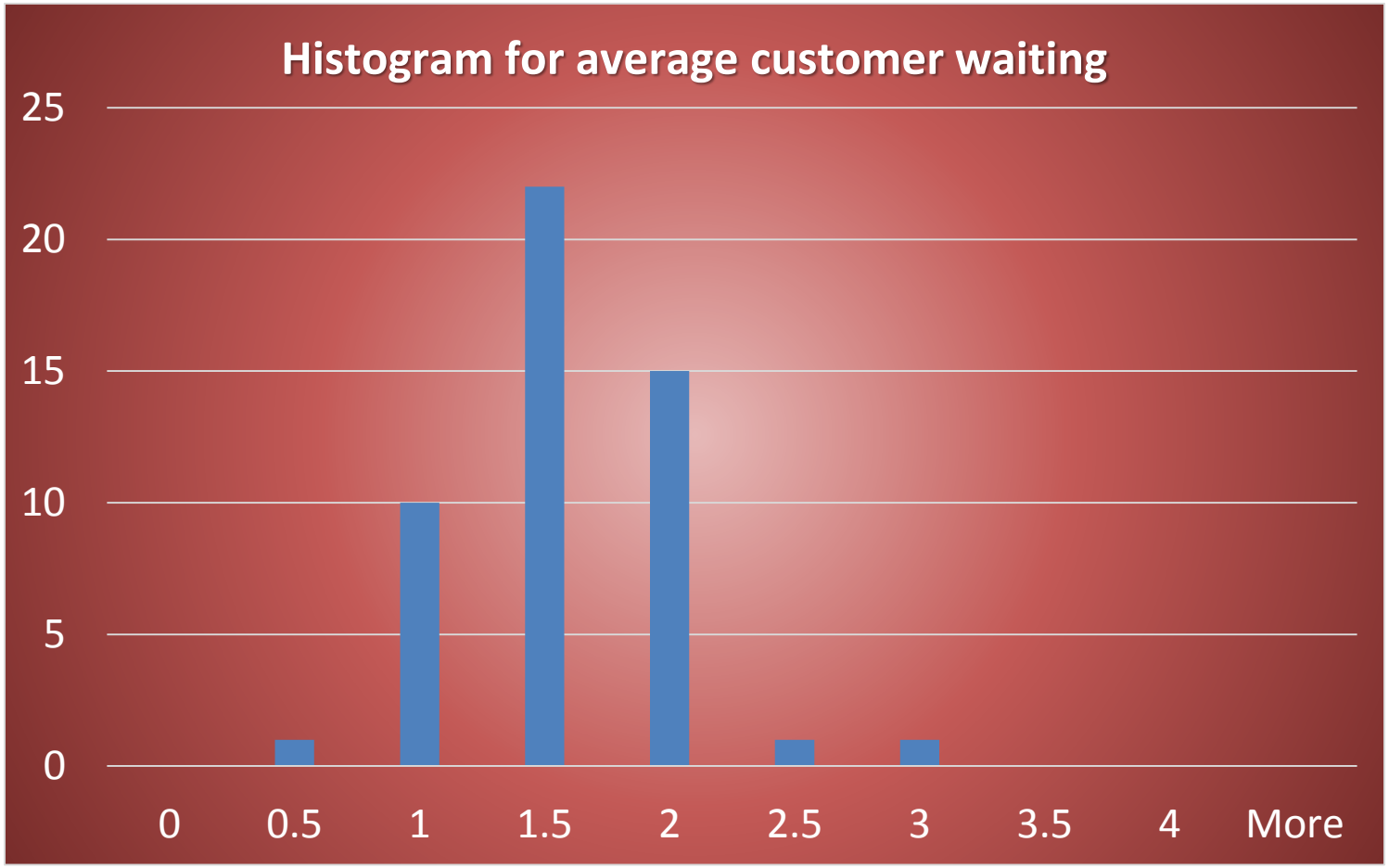
= 1.32 + 3.27

= 4.59 min

Typical Performance Measures of a Queuing System



Typical Performance Measures of a Queuing System



The experiment was run 50 times, each trial represents one day